United States Environmental Protection Agency **Office of Research and Development**

National Exposure Research Laboratory
FY02 Research Abstract

Government Performance Results Act (GPRA) Goal 1
APM

Significant Research Findings:

Community Multiscale Air Quality (CMAQ) Model - June 2002 Public Release Version

Scientific Problem and Policy Issues

The U.S. Environmental Protection Agency (EPA) and the states cooperate in implementing the provisions of the Clean Air Act Amendments (1990) for attaining National Ambient Air Quality Standards for criteria pollutants, including ozone and fine particulate matter. Typically air quality simulation models have been used in the implementation process for assessing the impacts of potential emissions mitigation strategies on the criteria pollutants. Our research has led to the latest version of the EPA's Community Multiscale Air Quality (CMAQ) modeling system, including a numerical grid model capable of simulating regional through urban patterns of ozone and photochemical oxidants, fine and coarse particulate matter, visibility, and acid deposition.

Research Approach

The CMAQ air quality model is driven by the MM5 meteorological model and the Sparse Matrix Operator Kernel Emissions (SMOKE) model. In this latest version of the modeling system, improvements have been made to all major components. A new land-surface and soil moisture model was added to the MM5 meteorological model to produce better representations of the evolution of the atmospheric mixed layer containing most of the pollutant burden. Also, a new interface processor was created to allow meteorological parameters to pass through directly from the MM5 model to the CMAQ air quality model. Previous model versions had required some meteorological parameters to be re-derived for CMAQ. A new biogenic emissions model, Biogenic Emissions Inventory System-Version 3, was included in the SMOKE emissions model. Emission factors of naturally-occurring hydrocarbons have been improved and refined in this model. Within the CMAQ model, a new chemical mechanism, SAPRC-99, developed at the University of California-Riverside, was added to the other two mechanisms already in CMAQ. A new, efficient numerical solution routine for the chemical equations was also implemented, resulting in faster CMAQ model run times. Refinements in the treatment of particulate matter were also included in this model version, including new aerosol yields from organic gas species and a new thermodynamics sub-model that has already seen community-wide use in other particulate matter models. Finally, a new routine for vertical diffusion, the Asymmetric Convective Model, was added as an option to CMAQ.

Results and Implications

The new version of the CMAQ modeling system has been tested on an application covering the continental United States at a 32-km horizontal grid dimension, with nested domains over the south-central states at an 8-km horizontal grid resolution, and over the Nashville, Tennessee region at a 2-km horizontal resolution. The time period modeled covered the first two weeks of July, 1999, at which time a field study was being conducted by the Southern Oxidants Study (SOS) over the Nashville region. Initial results from the test simulations indicated that the new version of the CMAQ model reproduced patterns of major pollutants during this time period reasonably well. At the national scale, air quality data from the Aerometric Information Retrieval System (AIRS) (ozone), Interagency Monitoring of Protected Visual Environments (IMPROVE), and Clean Air States and Trends Network (CASTNET) (particulate matter) monitoring networks were used to check model simulations. At the regional scale, data from the SOS/Nashville study were used. Results from these simulations were also compared with results using the previous version of the model. The introduction of new science and numerical routines in the CMAQ system over the last year have shown improvements in some of the model's pollutant concentration estimates. These early results indicate that the model is ready for more widespread applications and testing by the air quality research and management community.

Research Collaboration and Publications

The research leading to this latest version of the CMAQ modeling system was aided by collaborative work on the meteorological modeling with the Microelectronics Center of North Carolina (MCNC) and the National Center for Atmospheric Research (NCAR), on the emissions modeling with NCAR and the EPA's National Risk Management Research Laboratory (NRMRL), and on the chemical-transport modeling with MCNC and the University of California-Riverside (Dr. William Carter). The science within the CMAQ model is being documented in a journal article now in preparation. The modeling system is available for downloading at ftp://ftp.epa.gov/amd/stand_alone_models3/cmaq/.

Future Research

Intensive model evaluation exercises are now on-going with the June 2002 version of the CMAQ model. The model is being applied to the full summer 1999 ozone season, and special field data collected in the Nashville and Atlanta regions will be used to diagnostically evaluate the model for ozone and fine particulate matter and the precursor trace gases to these pollutants.

Contacts for Additional Information

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